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09/769,812	01/26/2001	Li-Te Lin	TS00-240	5166

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EXAMINER

VINH, LAN

ART UNIT	PAPER NUMBER
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1765

DATE MAILED: 10/22/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/769,812

Applicant(s)

LIN ET AL.

Examiner

Lan Vinh

Art Unit

1765

-- Th MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 28 July 2003.
- 2a) ☒ This action is FINAL. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,4-11 and 13-29 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 11 and 13-18 is/are allowed.
- 6) ☒ Claim(s) 1,4-10 and 19-29 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s) _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1, 5, 6, 8, 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ye et al (US 6,080,529) in view of Joubert et al (US 6,326,302)

Ye (529) discloses a method for etching patterned layer useful as masking for damascene structure. This method comprises the step of:

forming an organic low k dielectric layer 404 (polyarylene ether) over a substrate (col 21, lines 44-45)

forming a patterned hard mask layer 402 over low k dielectric layer 404, the layer 402 having openings (col 21, lines 44-45; fig.4A)

etching the low k dielectric layer 404 through the openings on the masking/resist pattern 402 using an etch process to form via 405/first opening, the etch process is conducted by applying bias plasma power to NH₃ gas in the chamber (col 22, lines 39-42, fig. 4B)

Ye differs from the instant claimed invention as per claim 1 by etching the organic low k dielectric layer by plasma etching using NH₃ gas instead of plasma etching using a process gas consisting of NH₃ and O₂.

Art Unit: 1765

However, Joubert discloses a process for the anisotropic etching of an organic dielectric polymer comprises the step of etching the dielectric organic layer using a plasma mixture of NH_3 / O_2 (col 3, lines 41-42), which reads on etching the dielectric organic layer using a plasma mixture consisting of NH_3 and O_2

Since Ye discloses the step of etching the polymeric organic low k dielectric layer 404, one skilled in the art would have found it obvious to modify Ye's etching step by using a etching mixture of NH_3 and O_2 as per Joubert since Joubert teaches that NH_3 and O_2 is the preferred mixture to etch organic dielectric polymer because of their low danger level during the etching step (col 3, lines 21-50)

Regarding claims 5-6, 8, Ye discloses that low k dielectric layer 404 made of polyarylene ether (col 21, lines 48-50)

Regarding claim 10, Ye discloses substrate 408 is made of aluminum/microelectronics conductor material.

3. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ye et al (US 6,080,529) in view of Joubert et al (US 6,326,302) and further in view of Bhardwaj et al (US 6,051,503).

Ye as modified by Joubert has been described above in paragraph 2. Although Ye discloses flowing 70 sccm of NH_3 gas (overlaps the claimed range of 50-300 sccm) and oxygen gas into the chamber at subatmospheric pressure while applying plasma power(col 12, lines 20-21; col 22, lines 41-42), Ye and Joubert do not disclose the specific values of the plasma density, power and pressure as recited in claim 2.

Art Unit: 1765

However, Bhardwaj, in a method of surface treatment using plasma, teaches that plasma density, plasma power and chamber pressure are parameters that can be varied to change the etch rate (col 2, lines 10-16)

Hence, one skilled in the art would have found it obvious to modify Ye and Joubert by varying the process parameters in view of Bhardwaj's teaching through routine experimentation to obtain particular values in order to achieve desirable etch rate. Also, it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980)

4. Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ye et al (US 6,080,529) in view of Joubert et al (6,326,302) and further in view of Naik et al (US 6,245,662)

Ye as modified by Joubert has been described above in paragraph 2. Ye and Joubert differ from the instant claimed invention as per claim 7 by forming a low k dielectric layer of polyarylene ether instead of carbon doped oxide.

However, Naik, in a method for forming interconnect structure, teaches that polyarylene ether or carbon doped oxide (Black diamond) can be used as low k dielectric material in an interconnect structure (col 3, lines 51-60)

Hence, one skilled in the art would have found it obvious to substitute Ye and Joubert polyarylene ether low k dielectric layer with carbon doped oxide in view of Naik's teaching because both materials are known low k dielectric materials, thus the substitution of one for the other would have produced an expected result.

Art Unit: 1765

5. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ye et al (US 6,080,529) in view of Joubert et al (US 6,326,302) and further in view of Bhardwaj et al (US 6,051,503) and McReynolds (US 6,191,043)

Ye, Joubert and Bhardwaj has been described above in paragraph 4. Unlike the instant claimed invention as per claim 9, Ye, Joubert and Bhardwaj do not specifically disclose forming a first opening through the low k dielectric layer, the opening having sidewalls that are substantially vertical at a angle between 87-93 degree to the surface of the substrate although Ye discloses forming contact via/opening 405 through the low k dielectric layer 404.

However, McReynolds discloses a method for etching a silicon layer comprises the step of the using plasma etching to etch an opening having sidewalls at a angle between 87 degree to the surface of the substrate (col 3, lines 20-22)

Hence, one skilled in the art would have found it obvious to modify Ye, Joubert and Bhardwaj by etching an opening having sidewalls at a angle of 87 degree to the surface of the substrate as taught by McReynolds because McReynolds teaches that opening having straight vertical profile (sidewalls at a angle of 87) has no problematic characteristics such as the bowed features that result from undercutting the hard mask (col 5, lines 30-33)

6. Claims 19, 22-24, 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ye et al (US 6,080,529) in view of Hsieh et al (US 6,455,431)

Art Unit: 1765

Ye discloses a method for etching patterned layer useful as masking for damascene structure. This method comprises the step of:

forming an organic low k dielectric layer 404 (polyarylene ether) over an insulating layer 406 over a substrate (col 21, lines 44-47)

forming a patterned hard mask layer 402 over low k dielectric layer 404, the layer 402 having openings (col 21, lines 44-45; fig.4A)

etching the low k dielectric layer 404 through the openings on the masking/resist pattern 402 using an etch process to form via 405/first opening, the etch process is conducted by applying bias plasma power to NH_3 gas in the chamber (col 22, lines 39-42). Since Ye is silent about performing a plasma treatment, Ye's etching step reads on the etch process does not comprise a plasma treatment.

Unlike the instant claimed invention as per claim 19, Ye fails to disclose flowing only NH_3 gas and N_2 to etch the organic low k dielectric layer.

However, Hsieh discloses a method for removing photoresist comprises the step of etching an opening in the low-k dielectric layer 404 using a gas mixture of ammonia and nitrogen (col 7, lines 11-28)

Hence, one skilled in the art would have found it obvious to modify Ye's step of etching the low k dielectric layer by etching a low k dielectric layer using NH_3 and N_2 plasma as per Hsieh because according to Hsieh using hydrogen/nitrogen (NH_3 and N_2) plasma source to etch the organic low-k dielectric layer is the most appropriate method for the particular dielectric material (col 7, lines 13-25)

Art Unit: 1765

Regarding claims 22-23, 25, Ye discloses that low k dielectric layer 404 made of polyarylene ether (col 21, lines 48-50)

The limitation of claim 24 has been discussed above in paragraph 5.

7. Claims 20-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ye et al (US 6,080,529) in view of Hsieh et al (US 6,455,431) and further in view of Bhardwaj et al (US 6,051,503).

Ye as modified by Hsieh has been described above in paragraph 6. Although Ye discloses flowing 70 sccm of NH_3 gas (overlaps the claimed range of 50-300 sccm) and oxygen gas into the chamber at subatmospheric pressure while applying plasma power(col 12, lines 20-21; col 22, lines 41-42), Ye and Hsieh do not disclose the specific values of the plasma density, power and pressure as recited in claims 20, 21.

However, Bhardwaj, in a method of surface treatment using plasma, teaches that plasma density, plasma power and chamber pressure are parameters that can be varied to change the etch rate (col 2, lines 10-16)

Hence, one skilled in the art would have found it obvious to modify Yeng and Hsieh method by varying the process parameters in view of Bhardwaj's teaching through routine experimentation to obtain particular values in order to achieve desirable etch rate. Also, it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980)

Art Unit: 1765

8. Claim 26 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ye et al (US 6,080,529) in view of Hsieh et al (US 6,455,431) and further in view of 6,080,529) in view of McReynolds (US 6,191,043)

Ye method as modified by Hsieh has been described above in paragraph 6. Unlike the instant claimed inventions as per claim 26, Ye and Hsieh not specifically disclose forming a first opening through the low k dielectric layer, the opening having sidewalls that are substantially vertical at an angle between 87-93 degree to the surface of the substrate although Ye discloses forming contact via/opening 405 through the low k dielectric layer 404.

However, McReynolds discloses a method for etching a silicon layer comprises the step of the using plasma etching to etch an opening having sidewalls at a angle between 87 degree to the surface of the substrate (col 3, lines 20-22)

Hence, one skilled in the art would have found it obvious to modify Ye and Hsieh method by etching an opening having sidewalls at a angle of 87 degree to the surface of the substrate as taught by McReynolds because McReynolds teaches that opening having straight vertical profile (sidewalls at a angle of 87) has no problematic characteristics such as the bowed features that result from undercutting the hard mask (col 5, lines 30-33)

9. Claims 27-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ye et al (US 6,080,529) in view of Hsieh et al (US 6,455,431) and further in view of Ye et al (US 6,458,516).

Art Unit: 1765

Ye (529) method as modified by Hsieh has been described above in paragraph 6. Regarding claim 27, Ye (529) discloses that the organic low k dielectric layer can be polyimide (col 23, lines 20-21) which reads on an organic spin-on material.

Ye (529) and Hsieh differ from the instant claimed invention as per claim 27 by etching the organic low k dielectric layer by plasma etching using NH_3 gas and N_2 gas instead of plasma etching gase of NH_3 and N_2 and O_2 .

However, Ye (516), in a method for etching dielectric, teaches that an organic material such as FLARE (polyarylene ether) can be patterned/etched by a plasma mixture of NH_3 and N_2 and O_2 . (col 22, lines 12-14)

Since Ye (529) discloses the step of etching the organic low k dielectric layer 404, one skilled in the art would have found it obvious to modify Ye (529) etching step by using a etching mixture of NH_3 and N_2 and O_2 as per Ye (516) because according to Ye (516) a etching mixture of NH_3 and N_2 and O_2 is a required etchant for etching organic dielectric material.

Allowable Subject Matter

10. Claims 11, 13-18 are allowed.

The following is an examiner's statement of reasons for allowance:

The cited prior art of record fails to disclose the step of etching the organic low k dielectric layer by gaseous plasma etching using NH_3 and H_2 and O_2/CO . The closest prior art of Ye et al (US 6,458,516) suggests etching the organic low k dielectric layer by gaseous plasma etching using NH_3 and N_2 and O_2

Art Unit: 1765

Response to Arguments

11. Applicant's arguments filed 7/28/2003 have been fully considered but they are not persuasive because the applicants have failed to response to the present examiner non-final rejection (paper no. 10) mailed on 4/28/2003. In fact, Applicant's arguments filed 7/28/2003 entirely response to the previous final-rejection (paper no.6) mailed on 12/27/2002.

12. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the mailing date of this final action.

Art Unit: 1765

Conclusion

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lan Vinh whose telephone number is 703 305-6302.

The examiner can normally be reached on M-F 8:30-5:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton, can be reached on 703 305-2667. The fax phone numbers for the organization where this application or proceeding is assigned are 703 872-9310 for regular communications and 703 872-9311 for After Final communications.

LV
October 5, 2003

NADINE G. NORTON
PRIMARY EXAMINER

